INTELLIGENT ROBUST CONTROL OF ACTIVE SUSPENSION SYSTEM

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To My Beloved Family...

For their Love, Encouragement, Sacrifice, and Best Wishes.

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ABSTRACT

This project presents a modelling and control of an active suspension system with hydraulic actuator dynamic for a quarter car model. The objective of designing a controller for the car suspension system is to improve the ride comfort while maintaining the constraints on to the suspension travel and tire deformation subject to different road profile. In this research, a cascade control algorithm which consists of the inner loop controller for force tracking control of the hydraulic actuator model and the outer loop controller for disturbance rejection control is proposed. Particle swarm optimization (PSO) algorithm is employed to optimize the PI controller parameters for force tracking control of the hydraulic actuator model. The outer loop controller utilizes a sliding mode controller scheme which incorporates PSO algorithm to efficiently reduce the influence of mismatched disturbance during sliding motion. In addition to that, the performance of the proposed sliding mode controller is compared with the LQR controller and the existing passive suspension system. Similarly, the values of Q and R for the LQR controller are optimized by PSO algorithm. A simulation study is performed to show the effectiveness and robustness of the proposed control algorithm. Eventually the results prove that the proposed controller improves the ride comfort by maintaining the other constrains (the suspension travel, tire deflection, and control force) in their limits.

ABSTRAK

Projek ini mempersembahkan pemodelan dan pengendalian sistem suspensi aktif dengan dinamik aktuator hidrolik untuk model kereta satu perempat. Tujuan rekabentuk pengawal sistem suspensi kereta adalah untuk meningkatkan keselesaan perjalanan sambil mengekalkan had-had tertentu terhadap suspensi perjalanan dan deformasi tayar mengikut profil jalan yang berbeza. Dalam projek ini, kami mencadangkan suatu algoritma kawalan sesiri yang terdiri daripada pengawal gelung dalaman untuk kawalan penjejakan daya bagi model aktuator hidrolik dan pengawal gelung luaran untuk pengawal penolak gangguan. *Particle Swarm Optimization* (PSO) digunakan untuk mengoptimumkan parameter kawalan PI untuk kawalan penjejakan daya bagi model aktuator hidrolik. Pengawal gelung luaran menggunakan skim Pengawal Ragam Gelineir (SMC) yang menggabungkan algoritma PSO untuk mengurangkan pengaruh gangguan tidak boleh dipadankan penolakan gangguan secara cekap. Prestasi pengawal SMC yang dicadangkan dibandingkan dengan pengawal LQR dan sistem suspensi yang ada pasif. Nilai Q dan R untuk pengawal LQR dioptimumkan dengan algoritma PSO. Satu kajian simulasi dilakukan untuk menunjukkan keberkesanan dan kelasakan algoritma kawalan yang dicadangkan. Keputusan menunjukkan bahawa pengawal yang dicadangkan meningkatkan keselesaan sambil mengekalkan had-had tertentu yang lain (perjalanan suspensi, pesongan tayar, dan daya kawalan) dalam had-had masing-masing.